Effect of Bandwidth Limiting on Stream Quality

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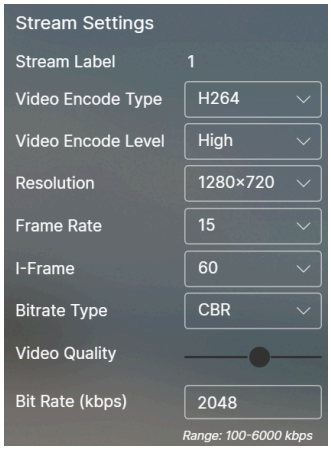
An experiment was conducted to determine how an enforced bandwidth limit affects the stream quality of ToughCam-1000™ cameras. A 100° FoV unit was mounted on a rotating turntable to simulate motion. The camera was streaming through a short 1m ethernet cable into an ethernet adapter plugged into a laptop. The camera was assigned the following settings:



The software NetLimiter was used to cap the bandwidth of the network interface to 2Mbps. Streaming through the ESTCameraApp, pixelation and frame drops were observed multiple times, on average there are 30s between occurrences. After turning off the bandwidth cap, the stream was smooth and stable. Iterative testing showed that a stable stream was achieved with a bandwidth cap of 2250kbps, 10% higher than the bitrate set on the camera at 2048kbps. This is due to occasional frames that push higher than the 2048kbps setpoint, such as iframes or high movement frames.

Based on the experiment setup at EST, headroom of 10% above the setpoint is necessary to ensure stable video streaming. We recommend at least a 10% buffer above the set bitrate for stable streaming.

Fig 1: Test Camera Settings

Further testing was completed to determine if a combination of camera settings can be configured to stabilize the video quality without changing the bitrate. Starting from the configuration in Fig 1, the video encode level, resolution, and frame rate were varied to see the impact on stream stability. The bandwidth cap was set at 2100kbps. The results of testing showed that changing these settings had minimal to no effect on removing the pixelation issue when a bandwidth limit too close to the set bitrate is in place. Having the camera set to VBR instead of CBR helped bring down the frequency of pixelation in lower movement scenes. However, with high motion frames, the bandwidth cap still caused pixelation issues. Ultimately the biggest difference to stream stability is reducing the bitrate. At lower bitrates, choosing a lower resolution such as VGA will result in a subjectively better video stream.

Recommendations for bandwidth limited networks:

Option 1: For a chosen bitrate with stream quality issues, ensure the consistently available bandwidth exceeds the bitrate by a minimum of 10% increase the bandwidth allocation to 10% above the bitrate for a smooth stream.

Option 2: For a network with a constrained bandwidth, ensure the total camera bitrate is at least 10% below the bandwidth limitation. Then choose a combination of resolution and camera settings that is acceptable for operation.